REMARKS/ARGUMENTS

Claims 1-10 and 23-29 are pending in the present application. Claims 11-22 have been withdrawn. In view of the Examiner's earlier restriction requirement, Applicants retain the right to present Claims 11-22 in a divisional application. Claims 1-10 and 23-29 have been rejected. In the present Amendment, Claims 1, 5, 7, and 23 have been amended.

REJECTIONS UNDER 35 U.S.C. §102

Claims 1-2, 5, 8-9, 23-24, and 28-29 have been rejected under 35 USC § 102(e) as being anticipated by U.S. Patent 6,280,868 to Badwal et al. Reconsideration is respectfully requested of these rejections based upon the following considerations.

Present Invention and Its Advantages

The present invention provides an etched interconnect for fuel cell elements comprising solid oxide electrolyte, an anode, and a cathode, and includes a single conductive base sheet having first and second major faces on opposite sides of the base sheet, anode gas flow passages disposed on the first face of the base sheet and cathode gas flow passages disposed on the second face of the base sheet. The anode gas flow passages and cathode gas flow passages each have a unique geometry prepared by chemical machining and selected to optimize fuel and oxidant gas flow according to system requirements. The anode gas flow passages comprise a large quantity of small diameter, closely spaced contact points and the cathode gas flow passages are configured to provide deep flow passages to promote oxidant mixing and a large surface area for optimum heat transfer to the cathode gas stream. The anode side etched geometry further provides a stiff, uniform support surface for the fuel cell. Cathode gas flow passages have a geometry configured to provide deep flow passages to promote oxidant mixing and a large surface area for optimum heat transfer to the cathode gas stream. The cathode

channel geometry also provides good electrical contact and a stiff, uniform structural support for the fuel cell. By providing a unique geometry to the cathode and anode gas flow passages, such as by varying the cross-section and width of the channels, flow velocity and turbulence may vary across the surface to optimize fuel utilization, fueling and power density. The invention allows application of different geometries for the anode and cathode flow passages simultaneously. There are few fabrication limitations because of the chemical machining process used to create the present geometry.

Distinctions Over Badwal

Badwal discloses an electrical interconnect device for a planar fuel cell having solid oxide electrolyte, a cathode and a nickel-containing anode comprising a plate-like chromium-containing substrate having fuel gas-flow channels on one side and an oxidation-resistant coating on surfaces of the anode. The coating comprises an outer oxygen barrier layer for electrically contacting the anode comprising Ni, a noble metal except Ag, or an alloy of one or more of these metals and an electrically conductive metal barrier layer comprising Nb, Ta, Ag or alloys of one or more of these metals between the substrate and the outer layer (see Abstract of Badwal).

Badwal does not teach or suggest an interconnect device having fuel and oxidant flow channels each having a unique geometry prepared by chemical machining and selected to optimize fuel and oxidant gas flow according to system requirements as presently disclosed and claimed. Claims 1 and 23 have been amended herein for clarification purposes and to make explicit this aspect of the invention that was implicit or inherent in the claims as originally presented.

Badwal shows identical channel geometry for both fuel and oxidant passages with ribs having a constant cross-section and a large amount of surface area. Badwal does not describe the size or shape of the identical fuel and oxidant gas flow channels except to say that the channels may be parallel or perpendicular (Column 5, lines 15-37). While the flow channels having the same geometry for both fuel and oxidant channels as taught in

Badwal may be "operational," "operational" is not the same as "optimal." The geometry taught in Badwal provides linear laminar flow. There is no mixing between the channels as provided by the present invention wherein cathode gas flow passages are configured to provide deep flow passages to promote oxidant mixing (See, for example, the instant specification at page 5, lines 1-5.)

Badwal teaches that cleaning the interconnect surface by etching, polishing/grinding, etc., prior to the application of the metal barrier layer may improve the quality of the oxidation-resistant coating. Badwal does not teach or suggest forming unique oxidant and gas flow channel geometry by chemical etching as in the present invention.

The ceramic fuel cell is not perfectly smooth but rather contains small irregularities on its surface. In the present invention of claim 2, the anode gas flow passage geometry comprises a large quantity of small diameter, closely spaced contact points. The multiplicity of smaller, closely spaced contact points increases the probability of contact with the irregular surface of the cell thereby improving contact.

In contrast, Badwal discloses a geometry comprising large wide ribs which provide top side and underside contact surfaces, not contact points. Only a few of the large, wide ribs surfaces as shown in Badwal will contact the high points of the fuel cell wall.

Badwal states that the interconnect should have a relatively high thermal conductivity to provide improved uniformity of heat distribution (Column 2, lines 19-21). The gas flow channel geometry of Badwal provides conductive heat transfer at the surfaces. However, the geometry taught in Badwal has a very limited convective heat transfer area.

Applicants note that the most important heat transfer is convective heat transfer which is based on the surface area of the sides of the channels more so than the top. The present invention provides optimum convective heat transfer because of our geometry wherein cathode gas flow channels comprise deep flow passages to promote oxidant

mixing and, because they are deep, a large surface area on the sides of the channels for optimum convective heat transfer to the cathode gas stream.

The present inventions includes a yielding layer disposed on one or more faces of said conductive base sheet, the yielding layer (claim 9) selected to enhance conformity of the interconnect to mating fuel cell surfaces.

Badwal teaches an oxidation-resistant coating on surfaces of the anode comprising an outer oxygen barrier layer electrically contacting the anode. The coating taught in Badwal is designed to resist oxidation and therefore maintain good electrical contact. The coating disclosed in Badwal is concerned with electrical contact and does not address surface contact between the interconnect and the mating fuel cell surfaces. There is nothing in Badwal that teaches or suggest a coating that conforms or yields to the fuel cell surfaces.

REJECTIONS UNDER 35 U.S.C. §103

Claims 3-4 and 6-7 have been rejected under 35 USC § 103(a) as being unpatentable over U.S. Patent 6,280,868 to Badwal et al. (hereinafter "Badwal") in view of U.S. Patent 6,361,892 to Ruhl et al. Claims 10 and 26 have been rejected under 35 USC § 103(a) as being unpatentable over Badwal in view of U.S. Patent 5,256,499 to Minh et al. (hereinafter "Minh"). Claim 25 has been rejected under 35 USC § 103(a) as being unpatentable over Badwal in view of U.S. Patent 6,024,859 to Hsu (hereinafter "Hsu"). Claim 27 has been rejected under 35 USC § 103(a) as being unpatentable over Badwal in view of U.S. Patent 4,510,212 to Fraioli (hereinafter "Fraioli"). Reconsideration is respectfully requested of these rejections based upon the following considerations.

Distinctions Over Badwal in view of Ruhl

With respect to claims 2-4 and 6-7, Ruhl discloses an electrochemical apparatus having at least one separator contacting the surfaces of one of the electrodes opposite the

electrolyte wherein the separator defines a micro-channel pattern which narrows towards the cell rim such that gas flowing out the rim is accelerated. Ruhl is consistent in using the terminology "micro" throughout, disclosing a "micro-channel" having a small size, on the order of about 0.5 millimeter or less.

The present invention is on a different scale, rather like a "macro" scale in comparison to Ruhl. The present anode gas flow passage geometry comprises a large quantity of small diameter, closely spaced contact points wherein the contact points are present on the anode face at a density of about 10 to about 25 contact points per square centimeter (claim 3) and wherein the contact points are generally round and have a diameter of about 0.5 to about 1 millimeter (claim 4). This anode side etched geometry provides good electrical contact to the fuel cell, provides flow passages allowing high swirl for optimum mixing of the fuel gas in combination with low pressure drop, and further provides a stiff, uniform support surface for the fuel cell. The present geometry provides shaped flow passages for generating swirl without excessive turbulence.

The present invention is not limited to size or depth of channels but further includes shape and orientation of features such as deep flow passages to promote oxidant mixing and a large side wall surface area for optimum heat transfer to the cathode gas stream (see embodiment shown in FIGS. 3 and 4 providing chevron shape forming oxidant flow channels).

Ruhl does not teach or suggest anode gas flow passages and cathode gas flow passages each having a unique geometry created by chemical machining on opposite sides of a single base sheet and selected to optimize fuel and oxidant gas flow as in the present invention. Ruhl does not teach or suggest a geometry on the same scale as the instant invention and does not discuss mixing or turbulence. Ruhl discusses shapes to control pressure drop and gas flow rate, but does not address heat transfer.

Distinctions Over Badwal in view of Minh

Minh discloses a solid oxide fuel cell having manifolds that are integrally formed with the fuel cell's core. The fuel cell includes repetitively stacked anode, electrolyte, cathode, interconnect, and gasket elements. The gasket elements space apart the interconnect and electrolyte elements and bound the anode and cathode elements. The interconnect, electrolyte and gasket elements are provided with cutouts that define manifold passageways for the fuel and oxidant. The gasket elements further prevent the fuel from contacting the cathode elements and the oxidant from contacting the anode elements.

Other processes, such as preparing shape pressings from green ceramic tapes and forming walls for the manifolds in the green tapes by pressing , vacuum forming, gear forming, etc. (Minh, Column 6, lines 1-30), limit the geometries that can be achieved in the flow field. Further, such processes do not allow for simultaneously preparing different channel geometries. Minh does not teach or suggest the present interconnect prepared using one process for etching anode gas flow passages and cathode gas flow passages each having a unique geometry on opposite sides of a single base sheet and selected to optimize fuel and oxidant gas flow as presently disclosed and claimed.

Distinctions Over Badwal in view of Hsu

Hsu does not teach or suggest gas supply manifolds comprising external stamped sheet metal manifolds secured to outer surfaces of the present fuel cell stack assembly comprising anode gas flow passages and cathode gas flow passages each having a unique geometry created by chemical machining on opposite sides of a single base sheet and selected to optimize fuel and oxidant gas flow as in the present invention.

Distinctions Over Badwal in view of Fraioli

Fraioli teaches a ceramic interconnect having little metal inserts and not a metal interconnect as in the present invention. See Fraioli at Column 8, lines 1-17 (small plugs of interconnect material 68 are extended through the inert support material 66 to

electrically contact the sandwiching layers of anode 60 and cathode 62). Fusing, as disclosed in Fraioli, refers to fusing green ceramic tapes together.

In the present invention, the ceramic cells are already hardened. Thus, the present invention is concerned with joining a fully sintered ceramic fuel cell to a fully metallic (conductive) interconnect. Claim 27, directed to a metal interconnect fused to a (hardened) fuel cell, is not taught or suggested in Fraioli.

Based upon the remarks presented herein, it is submitted that the Examiner's outstanding rejections have been overcome. As a result, Applicants respectfully request that a timely Notice of Allowance be issued in this case.

Should the Examiner have any questions regarding this matter, the Examiner is requested to contact Mr. Jimmy L. Funke, who may be reached in the Troy, Michigan area at (248) 813-1214.

If there are any additional charges with respect to this Response or otherwise, please charge them to Deposit Account No. 50-0831 maintained by Applicants' attorney.

Respectfully submitted,
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